PATENT ABSTRACTS OF JAPAN

(11)Publication number : 05-315174

(43)Date of publication of application : 26.11.1993

(51)Int.Cl.

H01F 41/02
B29C 47/54
H01F 1/053
H01F 1/06
H01F 1/08

(21)Application number : 04-119123

(22)Date of filing : 12.05.1992

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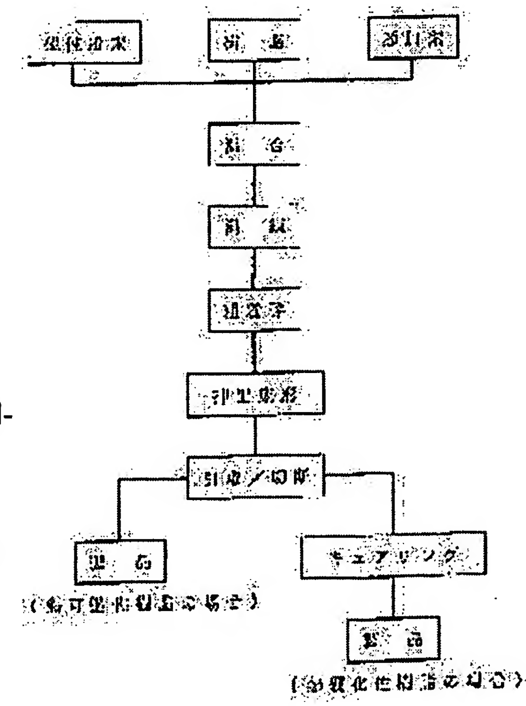
(54) RARE EARTH/RESIN-BOUND TYPE MAGNET AND MANUFACTURE THEREOF

(57)Abstract:

PURPOSE: To manufacture a high-performance rare earth/resin-bound type magnet in a high yield at a low cost by composing the material of rare earth magnetic powder, a thermoplastic resin and one or more types of additives including fluid auxiliary agent and adding a specific rare earth magnetic power to the above magnetic powder.

CONSTITUTION: A magnetic powder, a mixture of a Nd-Fe-B quenched magnetic powder and a globular atomized powder composed of, for example, Pr17Fe76.5B5 Cu1.5, a polyamide resin (nylon 12), and various molding auxiliary agents are weighed such that the volume ratio of the magnetic powder is 67%. These materials are mixed and kneaded, and the resultant mixture is extruded using a ram type extruder. The atomized powder is added at a rate of 1% or more to 100 of the quenched magnetic powder. This enables the manufacture of a magnet having a high fill factor.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

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(19)日本国特許庁（ＪＰ）　(12) 公開特許公報(Ａ)　(11)特許出願公開番号

特開平5−315174

(43)公開日　平成５年(1993)11月26日

(51)Int.Cl.⁵	識別記号	庁内整理番号	ＦＩ	技術表示箇所
Ｈ０１Ｆ　41/02	Ｇ	8019−5E		
Ｂ２９Ｃ　47/54		7717−4F		
Ｈ０１Ｆ　1/053				
			Ｈ０１Ｆ　1/ 04	Ｈ
			1/ 06	Ａ

審査請求　未請求　請求項の数４(全　７　頁)　最終頁に続く

(21)出願番号　特願平4−119123

(22)出願日　平成４年(1992)５月12日

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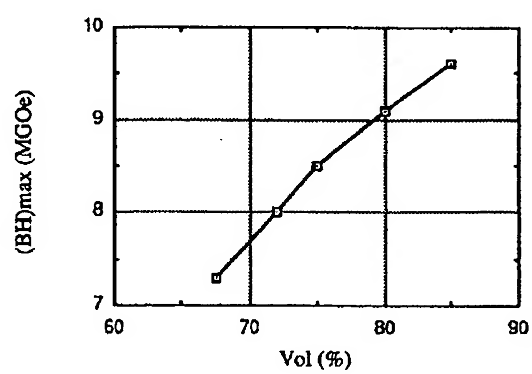
(54)【発明の名称】　希土類樹脂結合型磁石及びその製造方法

(57)【要約】

【目的】　希土類樹脂結合型磁石を高性能で生産性よく、低コストで製造する。

【構成】　ガスアトマイズ法で作製された球状の希土類磁石粉末と熱可塑性樹脂と流動助剤を含む一種類以上の添加剤からなる磁石を押出成形する。また、前記の製造方法において、押出機にラム式押出機を採用する。また、前記の希土類磁石粉末の基本組成が実質的にＲ、Ｆｅ、Ｂを主成分とする。



【特許請求の範囲】

【請求項１】　希土類磁石粉末と熱可塑性樹脂からなる希土類樹脂結合型磁石において、流動助剤を含む一種類以上の添加剤を添加し、かつガスアトマイズ法によって作製された球状の希土類磁石粉末を磁石粉末中に重量比で１％以上使用することを特徴とする希土類樹脂結合型磁石。

【請求項２】　ガスアトマイズ法で作製された球状の希土類磁石粉末を重量比で１％以上含有した希土類磁石粉末と熱可塑性樹脂と流動助剤を含む一種類以上の添加剤からなる磁石を押出成形法によって製造することを特徴とする希土類樹脂結合型磁石の製造方法。

【請求項３】　ガスアトマイズ法で作製された希土類磁石粉末と熱可塑性樹脂と流動助剤を含む一種類以上の添加剤からなる磁石をラム式押出機を使用して押出成形することを特徴とする希土類樹脂結合型磁石。

【請求項４】上記希土類磁石粉末の基本組成が実質的にＲ（Ｙを含む希土類元素のうち１種類または２種類以上）、Ｆｅ、Ｂを主成分とする請求項１、請求項２、および請求項３記載の希土類樹脂結合型磁石。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、希土類樹脂結合型磁石及びその製造方法に関する。

【０００２】

【従来の技術】樹脂結合型磁石の成形方法としては以下に示したような成形方法が上げられる。

【０００３】

１．　圧縮成形法

２．　射出成形法

圧縮成形法は磁石粉末と熱硬化性樹脂からなる磁石組成物をプレスの金型中に充填し、これに圧力を加えて圧縮して成形し、その後、加熱して樹脂を硬化させて成形する方法である。この時、磁石組成物中の磁性粉末量は９５ｗｔ％以上含まれる。この圧縮成形法は上記のように他の成形方法に比べ磁石組成物中の樹脂成分量が少ないため、成形された磁石の磁気性能は高いが、磁石の形状に対する自由度は小さい。

【０００４】射出成形法は磁石粉末と熱可塑性樹脂からなる磁石組成物を加熱溶融し、十分な流動性をもたせた状態で金型内に注入して所定の形状に成形する方法である。射出成形法は磁石組成物に流動性をもたせるために磁石組成物中の樹脂成分量が圧縮成形に比べて多く、磁石組成物中の磁石粉末量は９０～９５ｗｔ％となるために磁石成形体の磁気性能は低下する。しかし、形状の自由度は圧縮成形法に比べ大きい。

【０００５】

【発明が解決しようとする課題】しかしながら、上記の製造方法には以下に示すような課題を有している。

【０００６】第一に、圧縮成形法、射出成形法ともに成形工程が磁石組成物の金型への充填、成形、成形品の取りだしという一定のサイクルがあり、基本的にバッチ式生産システムであるため、その生産性には限界がある。

【０００７】また、射出成形法は形状自由度が高く、アーク形状の異形状磁石の成形が可能だが、スプルーやランナーが生じるためこれらのリサイクルを行なう必要がある。さらに希土類磁石粉末として特にＲ－Ｆｅ－Ｂ系磁石粉末を使用した磁石は高温雰囲気で劣化しやすいためリサイクル品を使用すると磁石の磁気性能を低下させるという問題点が生じる。

【０００８】そこで、これらの問題を解決する手段として押出成形法が挙げられる。押出成形法は磁石粉末を樹脂と混練し、この混練物（以後、磁石コンパウンドと称す）を押出機内で加熱し溶融状態としたところで金型内に送り込み金型内で賦形して成形する方法である。この方法の場合には生産工程が連続的なので、生産性が良く、また射出成形のようにスプルーやランナーを生じることが無いためリサイクルの必要がない。従ってこれによる磁気性能の低下は生じない。このように従来の圧縮成形や射出成形には無い利点を押出成形は有している。しかしながら、この押出成形法も以下の課題を有している。

【０００９】前述したように押出成形は磁石コンパウンドを押出機内で溶融状態とし、これに応力を加えることによって押出力とするが、溶融磁石コンパウンドは金属粉末である磁石粉末を含んでいるため、流動性が悪い。また、磁石粉末は流動時に金型壁面等との摩擦力を増大させ、これによる流動性の低下が生じる。樹脂結合型磁石は磁石粉末の充填量が高いほど磁気性能が高くなることから充填量は磁気性能面からは高い方が望ましい。しかし、前述の流動性は磁粉の充填量が高いほど低下するという問題点を有している。

【００１０】そこで本発明はこのような課題を解決するもので、その目的とするところは、高性能な希土類樹脂結合型磁石を低コストで生産性良く、提供するところにある。

【００１１】

【課題を解決するための手段】本発明の希土類樹脂結合型磁石は、希土類磁石粉末と熱可塑性樹脂および流動助剤を含む一種類以上の添加剤からなり、かつガスアトマイズ法によって製造された球状の希土類磁石粉末を磁石粉末中に重量比で１％以上使用することを特徴とする。

【００１２】また、上記組成物からなる磁石を、押出成形によって製造することを特徴とする。

【００１３】また、上記押出成形において、押出機にラム式押出機を使用することを特徴とする。

【００１４】また、上記希土類粉末の基本組成がＲ（Ｙを含む希土類元素）－Ｆｅ－Ｂであることを特徴とする。

【００１５】

【作用】本発明の製造方法によれば、希土類磁石粉末と樹脂からなる希土類樹脂結合型磁石の成形方法として押出成形法を用いることにより、基本的にバッチ処理である圧縮成形法や射出成形法等の従来製法に比べ、連続成形が可能となり、これによって生産性が上がり、低コスト化を図ることが可能となる。

【００１６】希土類磁石粉末と樹脂成分からなる磁石コンパウンドはコンパウンド中に金属粉末である磁石粉末を含んでいるため溶融時のコンパウンドの粘度が上昇することから、高性能な磁石を製造する場合には一層溶融磁石コンパウンドの流動性は低下する。それを解決する手段として２つの方法が考えられる。１つは、磁石コンパウンドの流動性を上げる方法と、もう１つは、押出圧力を上げる方法がある。

【００１７】前者の方法としてアトマイズ粉を使用することである。急冷法により作製された希土類磁石粉末は鱗片状であるのに対し、ガスアトマイズ法により作製された粉末は球状であるため、アトマイズ粉を使用することにより希土類磁石製造時の混練に際し、磁性粉の分散性や押出成形時の流動性が良くなり、成形品の均質性にもすぐれ、しかも充填量を増加させせることができる。

【００１８】このアトマイズ粉については必ずしも１００％使用する必要がなく、磁性粉末中に重量比で１％以上含むことにより、アトマイズ粉により固体潤滑剤的効果が得られ、流動し易くなる。ここで重量比で１％以上としたのは、これより少ない場合では固体潤滑剤的効果が得られないためである。

【００１９】さらに、流動性を上げるために、流動助剤を一種類以上添加することとした。磁粉と樹脂成分のみの場合には流動性が悪いため、一種類以上の流動助剤が必要となる。

【００２０】使用する流動助剤としてはステアリン酸等の脂肪酸、ステアリン酸亜鉛等の脂肪酸塩、シリコン化合物等の潤滑剤、およびシリカ粉末等の固体潤滑剤が考えられる。これらの流動助剤は一例であり、磁石コンパウンドの流動性を上げる物質であれば他のものを使用してもよいが、磁粉と樹脂成分のみの場合には流動性が悪いため、一種類以上の流動助剤が必要となる。 ＊

＊【００２１】また、後者の方法としてラム式押出機を採用した。ラム式押出機はシリンダー中に磁石コンパウンドを投入し、プランジャーの圧縮力によって押出を行なう押出機であり、スクリュー押出機に比べ押出機自体がバッチ処理となるため生産性が低下するという欠点を有するものの押出圧力についてはスクリュー式の上限が５００kg／cm²程度であるのに対し、３０００kg／cm²以上は十分にかけられることから、成形品のパッキング密度が高まり、成形可能な範囲を広げることが可能であるという利点を有するためである。

【００２２】使用する熱可塑性樹脂としては、ポリアミド樹脂、ＰＰＳ、液晶ポリマー等が挙げられる。これらの樹脂は成形性が良好であり、また耐薬品性、耐熱性、吸水性が良好であることから採用される。

【００２３】

【実施例】図１は本発明のガスアトマイズ法による希土類磁性粉末の製造工程を示している。１はアトマイズチャンバ、２は真空溶解炉、３は高周波誘導炉、４はタンディッシュで底部にはアルミナ製の小孔を有する溶湯ノズルが設置されている。５は真空用バルブ、６は不活性ガスを噴出するためのバルブ、７は粉末回収容器、８はエアー吸引可能なサイクロン、９は真空引き用バルブである。

【００２４】前述した第１図の粉末製造工程に於て、ＮｄもしくはＰｒ、Ｆｅ、Ｂ等からなる原料を真空溶解炉２にて、高周波誘導炉３内に装入し、不活性ガス雰囲気下で迅速溶解した後、あらかじめ外部より電気的に加熱されたタンディッシュ４に注湯する。そしてタンディッシュ４の底部に設置されている溶湯ノズルを３mmφ～７mmφまで変化させ、アトマイズチャンバ１内で粉霧化により粉末１０を製造し、回収容器７に回収した。

【００２５】次いで、各アトマイズ条件で得られた粉末を真空加熱炉または不活性ガス雰囲気下の加熱炉にて、一定温度で１時間熱処理を行ない、希土類磁石粉末を作製した。ここで作製したアトマイズ粉の組成を表１に示す。

【００２６】

【表１】

アトマイズ粉１	$Nd_{15}Fe_{72}Co_5B_8$
アトマイズ粉２	$Pr_{17}Fe_{76.5}B_5Cu_{1.5}$

【００２７】図２は本発明の希土類樹脂結合型磁石の製造工程を示している。希土類磁性粉末と樹脂と添加剤を所望の混合比に秤量した後にロールミール、押出機等の混合機で混合し、コンパウンドを作製する。このコンパウンドを成形機に投入しやすい大きさに粉砕し、押出成形機に投入する。ここで押出機には一軸のスクリュー式押出機もしくはラム式押出機を使用した。押出機内で磁石コンパウンドは加熱され、樹脂が溶融状態となり、この状態で押出機に接続された金型に送り込まれる。金型内でコンパウンドは最終形状に賦形され、金型から磁石成形体が押し出される。押し出された磁石は引き取られ、切断機によって切断される。この後熱硬化性樹脂を使用した場合にはキュアリングを行ない、希土類樹脂結合型磁石を成形した。また、磁場配向成形を行なった時

には切断前に脱磁を行なった。

【0028】以下、更に詳細な実施例を示す。

【0029】（実施例1）Nd－Fe－B系急冷磁石粉末（GM社製MQP－B）と表1に示したアトマイズ粉1及びポリアミド樹脂を磁石粉末の体積率が65％とな＊るように秤量した磁石コンパウンドにおいて、急冷粉とアトマイズ粉の量比を変えた時のそれぞれの成形速度を表2に示す。

【0030】

【表2】

組成物No.	急冷粉	アトマイズ粉	成形速度（mm／sec）
1	100.0	0.0	0.35
2	99.2	0.8	1.10
3	99.0	1.0	2.75
4	95.0	5.0	3.25
5	90.0	10.0	3.30
6	50.0	50.0	3.40
7	100.0	100.0	3.40

【0031】この表から見てわかるように、アトマイズ粉を1wt％以上入れると急冷磁粉だけの時に比べ、約8倍以上の成形速度を得ることが可能となる。

【0032】（実施例2）表3に急冷磁石粉末と表1に示したアトマイズ粉2が重量比で9：1の比である磁石粉末とポリアミド樹脂（ナイロン12）と各種成形助剤を磁石粉末の体積率が67％をなるように秤量し、これ※を混合混練し押出成形したときの成形速度を示す。押出機としては1軸スクリュー押出機を使用した。成形温度は230℃～270℃で成形を行なった。成形した形状は外径18mm、内径16mmのパイプ状磁石であった。

【0033】

【表3】

組成物No.	成形助剤	成形速度（mm／sec）
1	ステアリン酸	7.65
2	ステアリン酸亜鉛	6.75
3	シリコン化合物	8.55
4	シリカ粉末	6.45
5	なし	3.00

【0034】この表から見てわかるように、成形助剤を加えなかった組成物No.5の成形速度が3.0mm／secであったのに対し、各種成形助剤を加えた組成物の成形速度は6.5～8.6mm／secと、高い値を示した。これは成形助剤を加えたことにより組成物の流動性が上がったためである。また、成形速度が上がることにより、生産性の高い押出成形が可能となる。

【0035】（実施例3）図3は、急冷磁石粉末と表1に示したアトマイズ粉1が重量比で9：1の比である磁石粉末とナイロン12及び成形助剤としてシリコン化合物を加えた組成物の磁気性能（BH）maxを示す。

【0036】図4は、急冷法によって製造された磁石粉末（GM社製のMQP－B粉末を使用）とナイロン12及び成形助剤としてシリコン化合物を加えた組成物の磁気性能（BH）maxを示す。

【0037】図3、図4から見てわかるように、アトマイズ粉または急冷粉のどちらを使用しても、体積率が80％以下の時には同等の磁気性能を得られるが、アトマ

イズ粉を使用した場合、体積率が８０％を越えても成形が可能で、急冷粉を使用した場合、体積率が８２％になると成形を行なうことができなかった。

【００３８】これは、粉末の形状が球状であるアトマイズ粉を使用することによって、流動性が高くなるため、より高い体積率での成形が可能となることを示している。

【００３９】（実施例４）次に、表１に示したアトマイズ粉１または２とナイロン１２とステアリン酸からなる組成物をアトマイズ粉の体積率が７２％となるように秤量し、押出成形を行なった。この組成物の理論密度は５．７０ｇ／ｃｍ^{3}であって、スクリュー式とラム式を使って押出成形した時のそれぞれの密度、及び（ＢＨ）ｍａｘを表４に示す。

【００４０】

【表４】

成形機	アトマイズ粉	Br (kG)	iHc (kOe)	(BH) max	密度
ラム	1	6.52	11.30	8.3	5.68
ラム	2	6.59	9.25	8.4	5.68
スクリュー	1	6.20	11.15	7.7	5.59
スクリュー	2	6.26	9.07	7.8	5.60

【００４１】スクリュー式を使用した場合は、空気の巻き込み等のために密度が５．６０ｇ／ｃｍ^{3}とやや落ちるのに対し、ラム式を使用すると５．６８ｇ／ｃｍ^{3}と、理論密度に近い値になり、また、スクリュー式を使用した時よりも、高い磁気性能を得ることができる。

【００４２】次に、前期と同様の実験をアトマイズ粉の体積率を変えて行なった。結果を表５に示す。

【００４３】

【表５】

組成物Ｎｏ．	Ｖｏｌ％	成形機	成形品密度／理論密度 Ｘ１００％
1	７２	ラム	９９.６
2	７２	スクリュー	９８.２
3	８０	ラム	９９.３
4	８０	スクリュー	９６.０
5	８７	ラム	９９.０
6	８７	スクリュー	――――

【００４４】この表から見てわかるように、アトマイズ粉の体積率が同じであるコンパウンドを成形しても、ラム式を使用した場合、より理論密度に近い成形密度を得ることができた。尚、組成物Ｎｏ．６の結果が示されていないのは、アトマイズ粉の体積率が８７％のコンパウンドはスクリュー式では成形が不可能であったためである。

【００４５】これらの結果より、ラム式を使用することによって、より高い押出圧力をかけられるため空気の巻き込みの少ない、充填率の高い磁石ができ、磁石の高体積率化が図れる。また、成形可能な範囲を広げることが可能となる。

【００４６】

【発明の効果】以上実施例に示したように、本発明によれば、アトマイズ法および流動助剤を用いることにより粉末の流動性が上がり、また押出機にラム式を使用することにより充填率の高い磁石を製造することができ、高性能な希土類樹脂結合型磁石を生産性よく、低コストで

提供することが可能となる。

【図面の簡単な説明】

【図１】　図１は本発明の実施例におけるアトマイズ粉の製造工程の図。

【図２】　図２は本発明の希土類樹脂結合型磁石の製造工程の図。

【図３】　図３は本発明の実施例におけるアトマイズ粉の体積率と（ＢＨ）ｍａｘの関係を示す図。

【図４】　図４は本発明の実施例における急冷紛の体積率と（ＢＨ）ｍａｘの関係を示す図。＊

＊【符号の説明】

１・・・アトマイズチャンバ

２・・・真空溶解炉

３・・・高周波誘導炉

４・・・タンディッシュ

５・・・真空用バルブ

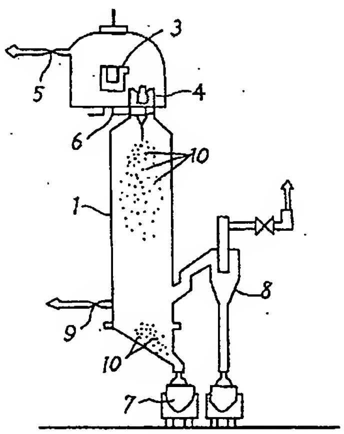
６・・・不活性ガスを噴出するためのバルブ

７・・・粉末回収容器

８・・・エアー吸引可能なサイクロン

９・・・真空引き用バルブ

【図１】



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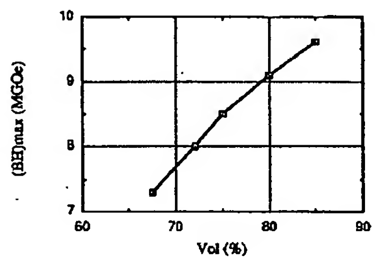
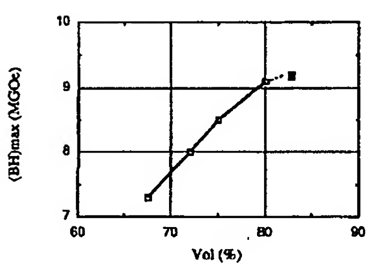
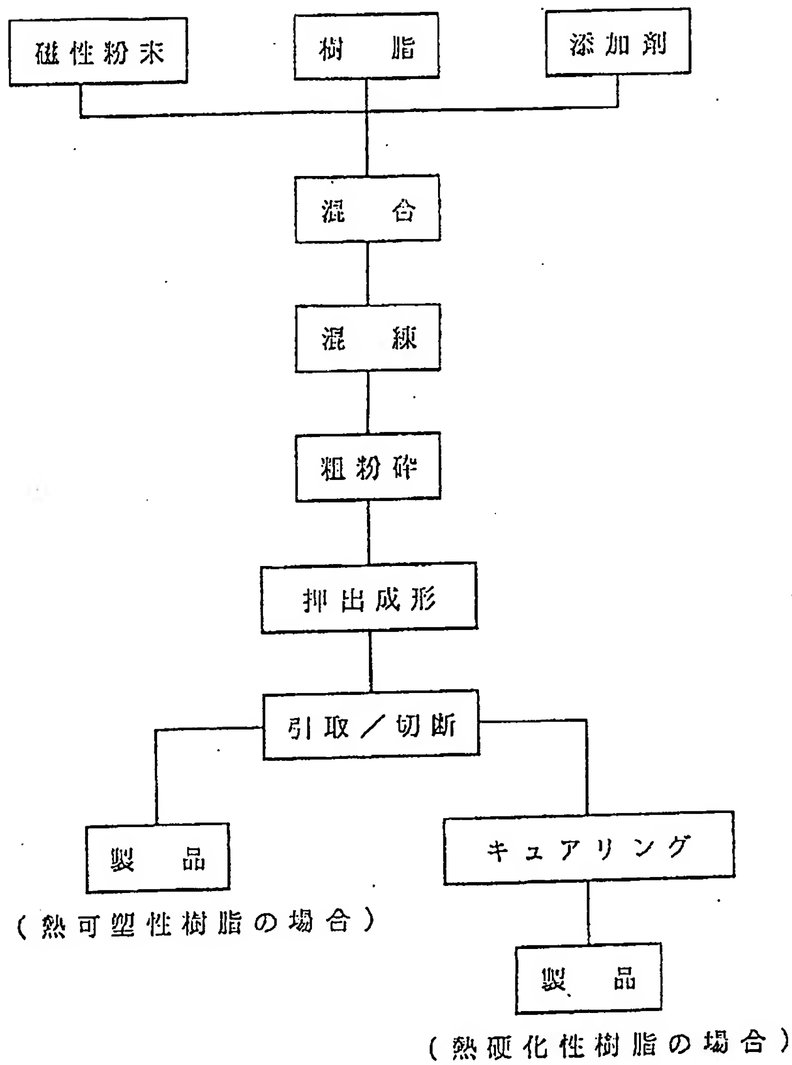


【図４】



【図2】



フロントページの続き

(51)Int.Cl.⁵		識別記号	庁内整理番号	F I	技術表示箇所
H01F	1/06				
	1/08		A		

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Bibliography

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(19) [Publication country] Japan Patent Office (JP)
(12) [Kind of official gazette] Open patent official report (A)
(11) [Publication No.] JP,5-315174,A
(43) [Date of Publication] November 26, Heisei 5 (1993)
(54) [Title of the Invention] A rare earth resin bond mold magnet and its manufacture approach
(51) [The 5th edition of International Patent Classification]
H01F 41/02 G 8019-5E
B29C 47/54 7717-4F
H01F 1/053
1/06
1/08 A
[FI]
H01F 1/04 H
1/06 A
[Request for Examination] Un-asking.
[The number of claims] 4
[Number of Pages] 7
(21) [Application number] Japanese Patent Application No. 4-119123
(22) [Filing date] May 12, Heisei 4 (1992)
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Epitome

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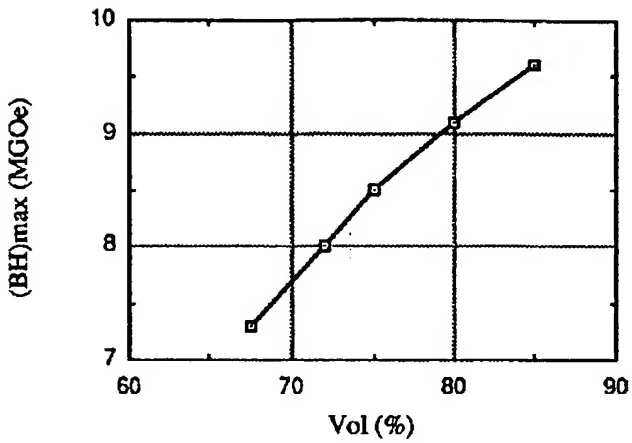
(57) [Abstract]
[Objects of the Invention] Productivity is good with high performance and a rare earth resin bond mold magnet is manufactured by low cost.
[Elements of the Invention] Extrusion molding of the magnet which consists of the spherical rare earth magnet powder and the thermoplastics which were produced by the gas atomizing method, and one or more kinds of additives containing a flow assistant is carried out. Moreover, a ram type extruder is adopted as an extruder in the aforementioned manufacture approach. Moreover, the basic presentation of the aforementioned rare earth magnet powder uses R, Fe, and B as a principal component substantially.

[Translation done.]



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CLAIMS

[Claim(s)]
[Claim 1] The rare earth resin bond mold magnet characterized by using the spherical rare earth magnet powder which added one or more kinds of additives containing a flow assistant in the rare earth resin bond mold magnet which consists of rare earth magnet powder and thermoplastics, and was produced by the gas atomizing method 1% or more by the weight ratio into magnet powder.
[Claim 2] The manufacture approach of the rare earth resin bond mold magnet characterized by manufacturing the magnet which consists of the rare earth magnet powder and thermoplastics which contained the spherical rare earth magnet powder produced by the gas atomizing method 1% or more by the weight ratio, and one or more kinds of additives containing a flow assistant by the extrusion method.
[Claim 3] The rare earth resin bond mold magnet characterized by

carrying out extrusion molding of the magnet which consists of the rare earth magnet powder and thermoplastics which were produced by the gas atomizing method, and one or more kinds of additives containing a flow assistant using a ram type extruder.

[Claim 4] Claim 1 to which the basic presentation of the above-mentioned rare earth magnet powder uses R (it is one kind or two kinds or more in the rare earth elements containing Y), Fe, and B as a principal component substantially, claim 2, and a rare earth resin bond mold magnet according to claim 3.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention relates to a rare earth resin bond mold magnet and its manufacture approach.

[0002]

[Description of the Prior Art] The shaping approach as shown below as the shaping approach of a resin bond mold magnet is raised.

[0003]

1. Compression-forming 2. Injection-molding method compression forming is the approach of being filled up with the magnet constituent which consists of magnet powder and thermosetting resin into the metal mold of a press, and applying, compressing and fabricating a pressure to this, and heating, making harden resin after that and fabricating. this time -- the amount of magnetic powder in a magnet constituent -- more than 95wt% -- it is contained. Although the magnetic magnetic engine performance in which this compression forming was fabricated since there were few amounts of resinous principles in a magnet constituent compared

with the shaping approach of others as mentioned above is high, the degree of freedom to a magnetic configuration is small.

[0004] An injection-molding method is the approach of carrying out heating fusion of the magnet constituent which consists of magnet powder and thermoplastics, pouring in into metal mold, where sufficient fluidity is given, and fabricating in a predetermined configuration. An injection-molding method has many amounts of resinous principles in a magnet constituent compared with compression molding, in order to give a fluidity to a magnet constituent, and since the amount of magnet powder in a magnet constituent becomes 90 - 95wt%, the magnetic engine performance of a magnet Plastic solid falls. However, the degree of freedom of a configuration is large compared with compression forming.

[0005]

[Problem(s) to be Solved by the Invention] However, in the above-mentioned manufacture approach, it has the technical problem as shown below.

[0006] In the first place, compression forming and an injection-molding method have a fixed cycle called extraction of the restoration to the metal mold of a magnet constituent, shaping, and mold goods in a forming cycle, and since it is a batch type production system fundamentally, there is a limitation in the productivity.

[0007] Moreover, although an injection-molding method has a high configuration degree of freedom and shaping of the anomaly-like magnet of an arc configuration is possible, since sprue and a runner arise, it is necessary to perform these recycle. Since the magnet which furthermore used R-Fe-B system magnet powder especially as rare earth magnet powder tends to deteriorate in an elevated-temperature ambient atmosphere, if a recycle article is used, the trouble of reducing the magnetic magnetic engine performance will produce it.

[0008] Then, an extrusion method is mentioned as a means to solve these problems. An extrusion method is the approach of sending in in metal mold in the place which kneaded magnet powder with resin, heated this kneading object (a magnet compound is called henceforth) within the extruder, and was made into the melting condition, and carrying out size enlargement and fabricating within metal mold. Since the production process is continuous in the case of this approach, and productivity produces neither sprue nor a runner like injection molding well, there is no need for recycle. Therefore, the magnetic performance degradation by this is not produced. Thus, extrusion molding has the advantage which is not in conventional compression molding or conventional injection molding. However, this extrusion method also has the following technical

problems.

[0009] Although extrusion molding makes a magnet compound a melting condition within an extruder as mentioned above, and considered as extrusion force by applying stress to this, since the melting magnet compound contains the magnet powder which is metal powder, its fluidity is bad. Moreover, magnet powder increases frictional force with a metal mold wall surface etc. at the time of a flow, and the fluid fall by this produces it. Since, as for a resin bond mold magnet, the magnetic engine performance becomes high so that the fill of magnet powder is high, from a magnetic engine-performance side, the higher one of a fill is desirable. However, the above-mentioned fluidity has the trouble of falling, so that the fill of magnetic powder is high.

[0010] Then, this invention solves such a technical problem and the place made into the purpose is located in the place which productivity is good and offers a highly efficient rare earth resin bond mold magnet by low cost.

[0011]

[Means for Solving the Problem] The rare earth resin bond mold magnet of this invention is characterized by using the spherical rare earth magnet powder which consisted of one or more kinds of additives containing rare earth magnet powder, thermoplastics, and a flow assistant, and was manufactured by the gas atomizing method 1% or more by the weight ratio into magnet powder.

[0012] Moreover, it is characterized by manufacturing the magnet which consists of the above-mentioned constituent by extrusion molding.

[0013] Moreover, in the above-mentioned extrusion molding, it is characterized by using a ram type extruder for an extruder.

[0014] Moreover, it is characterized by the basic presentation of the above-mentioned rare earth powder being R(rare earth elements containing Y)-Fe-B.

[0015]

[Function] By using an extrusion method as the shaping approach of the rare earth resin bond mold magnet which consists of rare earth magnet powder and resin, compared with the conventional processes which are batch processing fundamentally, such as compression forming and an injection-molding method, continuous molding becomes possible, productivity goes up by this, and, according to the manufacture approach of this invention, it becomes possible to attain low cost-ization.

[0016] Since the magnet compound which consists of rare earth magnet powder and a resinous principle contains in the compound the magnet powder which is metal powder, in manufacturing a highly efficient magnet

from the viscosity of the compound at the time of melting rising, the fluidity of a melting magnet compound falls further. Two approaches can be considered as a means to solve it. The approach one raises the fluidity of a magnet compound, and another have the approach of raising extrusion pressure.

[0017] It is using an atomizing powder as the former approach. Since the powder produced by the gas atomizing method to the rare earth magnet powder produced by the quenching method being a scale-like is spherical, on the occasion of kneading at the time of rare earth magnet manufacture, the dispersibility of magnetic powder and the fluidity at the time of extrusion molding can become good, and it can be excellent also in the homogeneity of mold goods, and, moreover, can make a fill increase by using an atomizing powder.

[0018] It is not necessary to necessarily use it 100% about this atomizing powder, and solid lubricant-effectiveness is acquired by the atomizing powder and it becomes easy to flow by containing 1% or more by the weight ratio in magnetic powder. Because solid lubricant-effectiveness was not acquired in the case of being fewer than this, it could be 1% or more by the weight ratio here.

[0019] Furthermore, in order to raise a fluidity, we decided to add one or more kinds of flow assistants. Only in the case of magnetic powder and a resinous principle, since the fluidity is bad, one or more kinds of flow assistants are needed.

[0020] As a flow assistant to be used, solid lubricants, such as lubricant, such as fatty-acid salts, such as fatty acids, such as stearin acid, and zinc stearate, and a silicon compound, and silica powder, can be considered. As long as these flow assistants are examples and it is the matter which raises the fluidity of a magnet compound, other things may be used, but only in the case of magnetic powder and a resinous principle, since the fluidity is bad, one or more kinds of flow assistants are needed.

[0021] Moreover, the ram type extruder was adopted as the latter approach. It is the extruder which a ram type extruder supplies a magnet compound in a cylinder, and performs extrusion according to the compressive force of a plunger. As opposed to the upper limit of a screw type being about 500kg/cm2 about extrusion pressure, although it has the fault that productivity falls, since the extruder itself serves as batch processing compared with a screw extruder It is because it has the advantage that it is possible for 3000kg/cm2 or more of packing consistencies of mold goods to increase since it is fully applied, and to extend the range which can be fabricated.

[0022] As thermoplastics to be used, polyamide resin, PPS, a liquid crystal polymer, etc. are mentioned. These resin is adopted from a moldability being good and chemical resistance, thermal resistance, and absorptivity being good.
[0023]
[Example] Drawing 1 shows the production process of the rare earth magnetism powder by the gas atomizing method of this invention. As for 1, the molten metal nozzle for which an atomization chamber and 2 have a vacuum melting furnace, and 3 has a high frequency induction furnace and the stoma of the product [4 / pars basilaris ossis occipitalis] made from an alumina in tundish is installed. A bulb for 5 to spout the bulb for vacuums and for 6 spout inert gas, a cyclone with 7 [possible / Ayr suction / the container for powder recycling and 8], and 9 are the bulbs for vacuum suction.
[0024] In the powder production process of Fig. 1 mentioned above, after it inserts in the raw material which consists of Nd, Pr, Fe, B, etc. in a high frequency induction furnace 3 and it carries out rapid lysis under an inert gas ambient atmosphere with a vacuum melting furnace 2, teeming is carried out to the tundish 4 heated beforehand more electrically than the exterior. And the molten metal nozzle currently installed in the pars basilaris ossis occipitalis of tundish 4 was changed to 3mmphi-7mmphi, powder 10 was manufactured by spray-ization within the atomization chamber 1, and it collected in the container 7 for recycling.
[0025] Subsequently, the vacuum heating furnace or the heating furnace under an inert gas ambient atmosphere performed the powder obtained on each atomization conditions, heat treatment was performed with constant temperature for 1 hour, and rare earth magnet powder was produced. The presentation of the atomizing powder produced here is shown in Table 1.
[0026]
[Table 1]

アトマイズ粉1	$Nd_{15}Fe_{72}Co_5B_8$
アトマイズ粉2	$Pr_{17}Fe_{76.5}B_5Cu_{1.5}$

[0027] Drawing 2 shows the production process of the rare earth resin bond mold magnet of this invention. After carrying out weighing capacity of rare earth magnetism powder, resin, and the additive to a desired mixing ratio, it mixes with mixers, such as a roll meal and an extruder, and a compound is produced. It grinds in the magnitude which is easy to

supply this compound to a making machine, and supplies to an extruding press machine. The screw-type extruder or ram type extruder of one shaft was used for the extruder here. A magnet compound is heated within an extruder, resin will be in a melting condition, and it will be sent into the metal mold connected to the extruder in this condition. Size enlargement of the compound is carried out to the last configuration within metal mold, and a magnet Plastic solid is extruded from metal mold. The extruded magnet is taken over and cut by the cutting machine. When thermosetting resin was used after this, curing was performed, and the rare earth resin bond mold magnet was fabricated. Moreover, when magnetic field orientation shaping was performed, demagnetization was performed before cutting.

[0028] Hereafter, a still more detailed example is shown.

[0029] (Example 1) In the magnet compound which carried out weighing capacity of the atomizing powder 1 and polyamide resin which were shown in Nd-Fe-B system quenching magnet powder (GMMQP-B) and Table 1 so that the rate of the volume of magnet powder might become 65%, each shaping rate when changing the quantitative ratio of quenching powder and an atomizing powder is shown in Table 2.

[0030]

[Table 2]

組成物Ｎｏ.	急冷粉	アトマイズ粉	成形速度（ｍｍ／ｓｅｃ）
1	100.0	0.0	0.35
2	99.2	0.8	1.10
3	99.0	1.0	2.75
4	95.0	5.0	3.25
5	90.0	10.0	3.30
6	50.0	50.0	3.40
7	100.0	100.0	3.40

[0031] this table sees and shows -- as -- an atomizing powder -- more than 1wt% -- if it puts in, compared with the time only of quenching magnetic powder, it will become possible to obtain the shaping rate of about 8 times or more.

[0032] (Example 2) The shaping rate when having carried out weighing capacity of the magnet powder, the polyamide resin (Nylon 12), and the various shaping assistants whose atomizing powders 2 shown in Table 3 in quenching magnet powder and Table 1 are the ratios of 9:1 in a weight ratio so that the rate of the volume of magnet powder might become about 67%, carrying out mixed kneading and carrying out extrusion molding of this is shown. 1 shaft screw extruder was used as an extruder. Molding temperature fabricated at 230 degrees C - 270 degrees C. The fabricated configuration was a pipe-like magnet with an outer diameter [of 18mm], and a bore of 16mm.
[0033]
[Table 3]

組成物No.	成形助剤	成形速度（mm／sec）
1	ステアリン酸	7.65
2	ステアリン酸亜鉛	6.75
3	シリコン化合物	8.55
4	シリカ粉末	6.45
5	なし	3.00

[0034] As seen and shown in this table, the shaping rate of the constituent which added various shaping assistants indicated the high value to be 6.5 - 8.6 mm/sec to the shaping rates of constituent No.5 which did not add a shaping assistant having been 3.0 mm/sec. This is because the fluidity of a constituent went up by having added the shaping assistant. Moreover, when a shaping rate increases, extrusion molding with high productivity becomes possible.
[0035] (Example 3) Drawing 3 shows magnetic (engine-performance BH) max of a constituent which added the silicon compound as the magnet powder whose atomizing powder 1 shown in quenching magnet powder and Table 1 is the ratio of 9:1 in a weight ratio, Nylon 12, and a shaping assistant.
[0036] Drawing 4 shows magnetic (engine-performance BH) max of a constituent which added the silicon compound as the magnet powder (the GM MQP-B powder is used) manufactured by the quenching method, Nylon 12, and a shaping assistant.
[0037] It was not able to fabricate, when it was able to fabricate even if the rate of the volume exceeded 80% when atomization complications were used although the equivalent magnetic engine performance could be

obtained when the rate of the volume was 80% or less whichever it used [of atomization complications or quenching complications] it so that drawing 3 and drawing 4 might see and show, quenching complications were used, and the rate of the volume became 82%.
[0038] Since a fluidity becomes high by using atomization complications with a powdered spherical configuration, this shows that shaping at the higher rate of the volume is attained.
[0039] (Example 4) Next, weighing capacity of the constituent which consists of the atomizing powders 1 or 2 and Nylon 12 which were shown in Table 1, and stearin acid was carried out so that the rate of the volume of atomization complications might become 72%, and extrusion molding was performed. 5.70g /of theoretical density of this constituent is [cm] 3, and it shows each consistency when carrying out extrusion molding using a screw type and a ram type, and (BH) max in Table 4.
[0040]
[Table 4]

成形機	アトマイズ粉	Br (kG)	iHc (kOe)	(BH) max	密度
ラム	1	6.52	11.30	8.3	5.68
ラム	2	6.59	9.25	8.4	5.68
スクリュー	1	6.20	11.15	7.7	5.59
スクリュー	2	6.26	9.07	7.8	5.60

[0041] When a screw type is used, the magnetic engine performance higher than the time of becoming 5.68 g/cm3 and a value near theoretical density when the consistency used the ram type to falling a little with 5.60 g/cm3 for the contamination of air etc., and using a screw type can be obtained.
[0042] Next, the rate of the volume of atomization complications was changed and the same experiment as the first half was conducted. A result is shown in Table 5.
[0043]
[Table 5]

組成物No.	Vol%	成形機	成形品密度／理論密度 X100%
1	72	ラム	99.6
2	72	スクリュー	98.2
3	80	ラム	99.3
4	80	スクリュー	96.0
5	87	ラム	99.0
6	87	スクリュー	――

[0044] When a ram type was used even if the rate of the volume of atomization complications fabricated the same compound as seen and shown in this table, the shaping consistency more near theoretical density was able to be obtained. In addition, the compound whose rate of the volume of atomization complications of the result of constituent No.6 not being shown is 87% is because it was not able to fabricate in a screw type.

[0045] From these results, by using a ram type, since higher extrusion pressure can be put, the high magnet of a filling factor with little contamination of air is made, and magnetic rate-ization of the high volume can be attained. Moreover, it becomes possible to extend the range which can be fabricated.

[0046]

[Effect of the Invention] As shown in the example above, by using the atomizing method and a flow assistant, by a powdered fluidity's going up and using a ram type for an extruder, the high magnet of a filling factor can be manufactured and, according to this invention, it becomes possible for productivity to be good and to offer a highly efficient rare earth resin bond mold magnet by low cost.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Drawing 1 is drawing of the production process of the atomization complications in the example of this invention.
[Drawing 2] Drawing 2 is drawing of the production process of the rare earth resin bond mold magnet of this invention.
[Drawing 3] Drawing 3 is drawing showing the rate of the volume of atomization complications and the relation of (BH) max to the example of this invention.
[Drawing 4] Drawing 4 is drawing showing the rate of the volume of quenching complications and the relation of (BH) max to the example of this invention.
[Description of Notations]
1 ... Atomization chamber
2 ... Vacuum melting furnace
3 ... High frequency induction furnace
4 ... Tundish
5 ... Bulb for vacuums
6 ... Bulb for spouting inert gas
7 ... Container for powder recycling
8 ... Cyclone in which Ayr suction is possible
9 ... Bulb for vacuum suction

[Translation done.]

* NOTICES *

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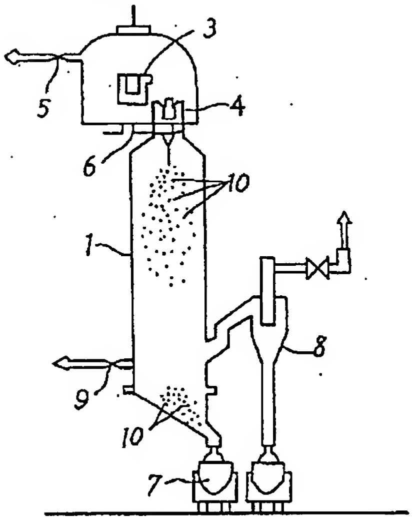
damages caused by the use of this translation.
1. This document has been translated by computer. So the translation may not reflect the original precisely.

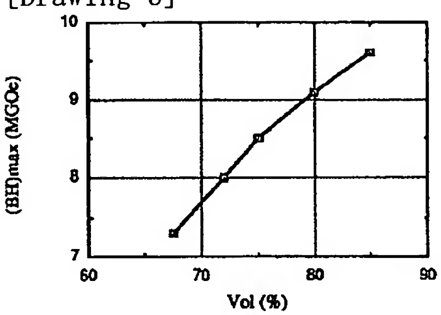
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DRAWINGS

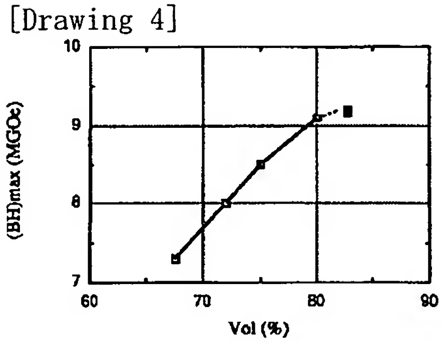
[Drawing 1]



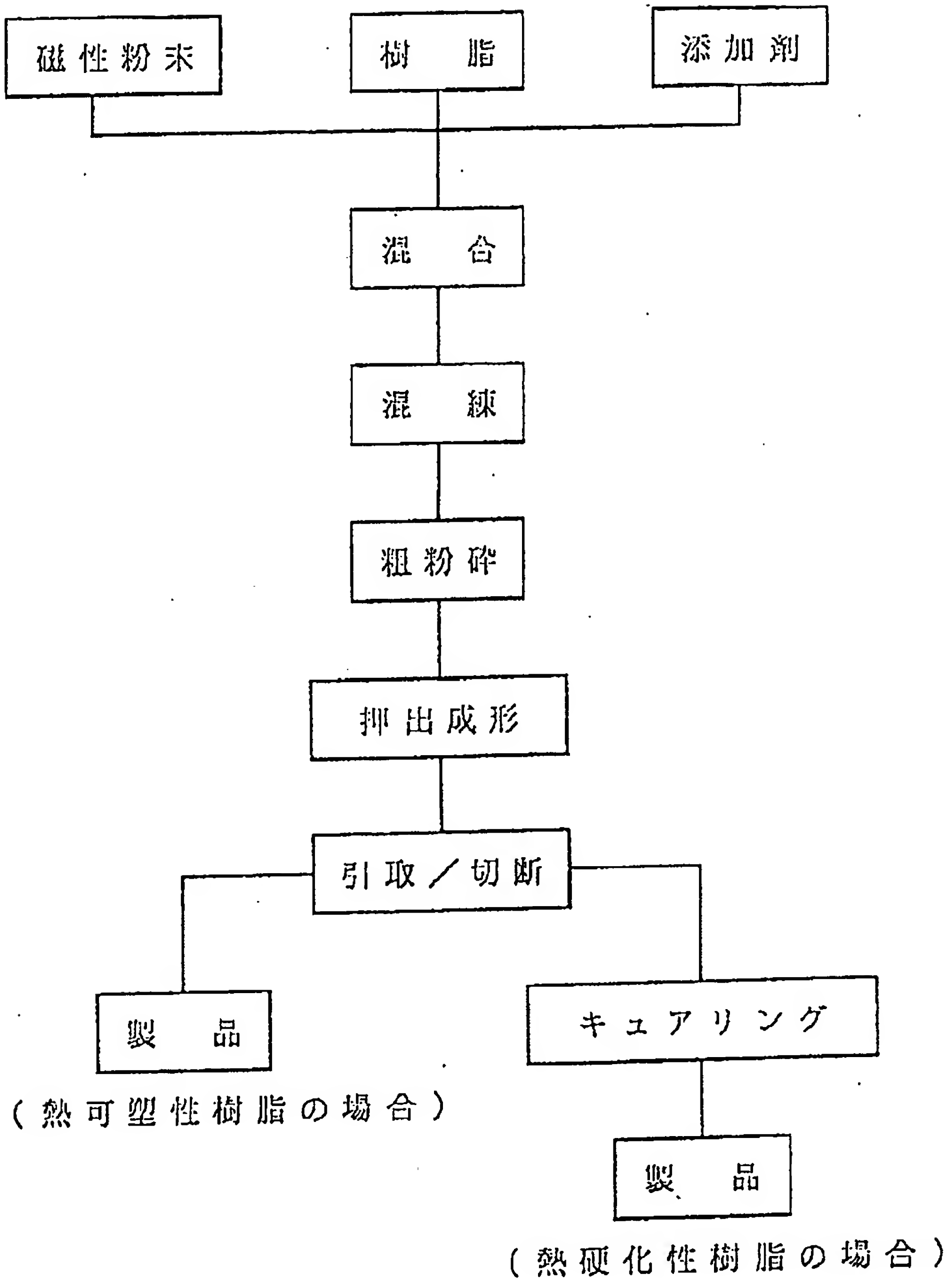
[Drawing 3]



[Drawing 4]



[Drawing 2]



[Translation done.]